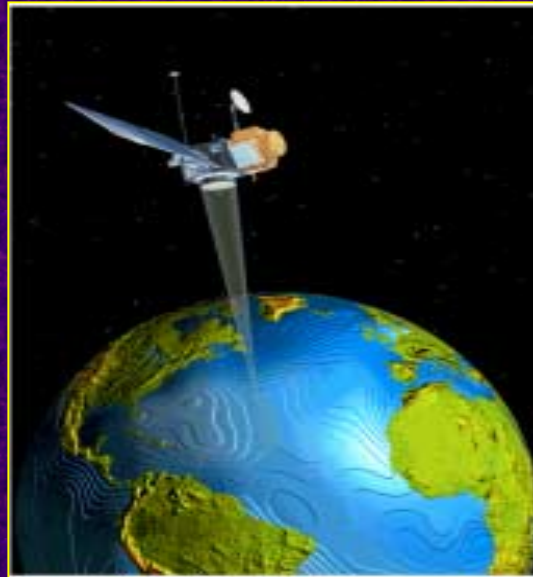


Jan. 28, 2006

# Central Valley Spatial Reference Network (CVSRN)



## Caltrans-Central Region Fresno

Presenter

Giana "Gigi" Cardoza, PLS

Caltrans Transportation Surveyor Party Chief



# Presentation Outline

- What is the CVSRN?
- Network Design
- Why Network? Why now?
- Site Design & Analysis
- Site Monuments & Installation
- Communications / Telemetry
- I T Configuration
- Software Evaluations
- Users
- Partnering
- Support
- Cost Recovery
- Pilot Project Goals
- Schedule
- Build-out plan
- End



# What is it?

## Central Valley Spatial Reference Network

The CVSRN is a project that will be comprised of Global Positioning System (GPS) stations that are permanently in place and operate continuously. The data from this network will be used for post processing as well as instantaneous real time positioning.

# The Initial Idea.

Direct result of education and circumstances.

- Facilitating in-kind services with CSRC-Height Modernization Project.  
Monument setting.  
GPS Observations.  
High Precision Leveling. (State Highways 152, and 198)
- Involvement with various GPS Users Groups throughout the State.
- Facilitating PBO in permitting sites along State Right of Way.

(CSRC-California Spatial Reference Center / PBO-Plate Boundary Observatory)

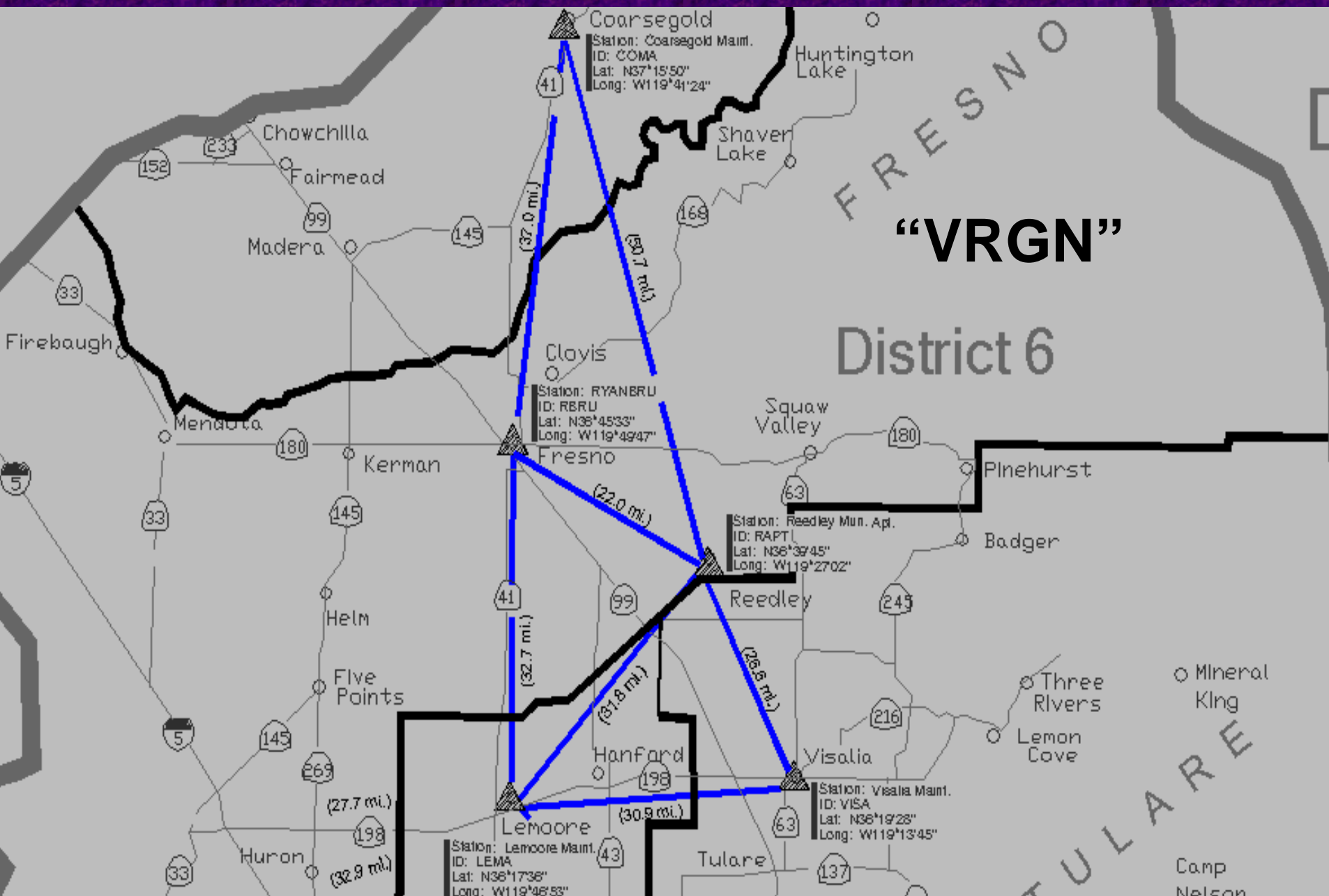


# Fresno Area Real-time Network

[illegible]

# Revision #1

# Valley Real-time Geodetic Network

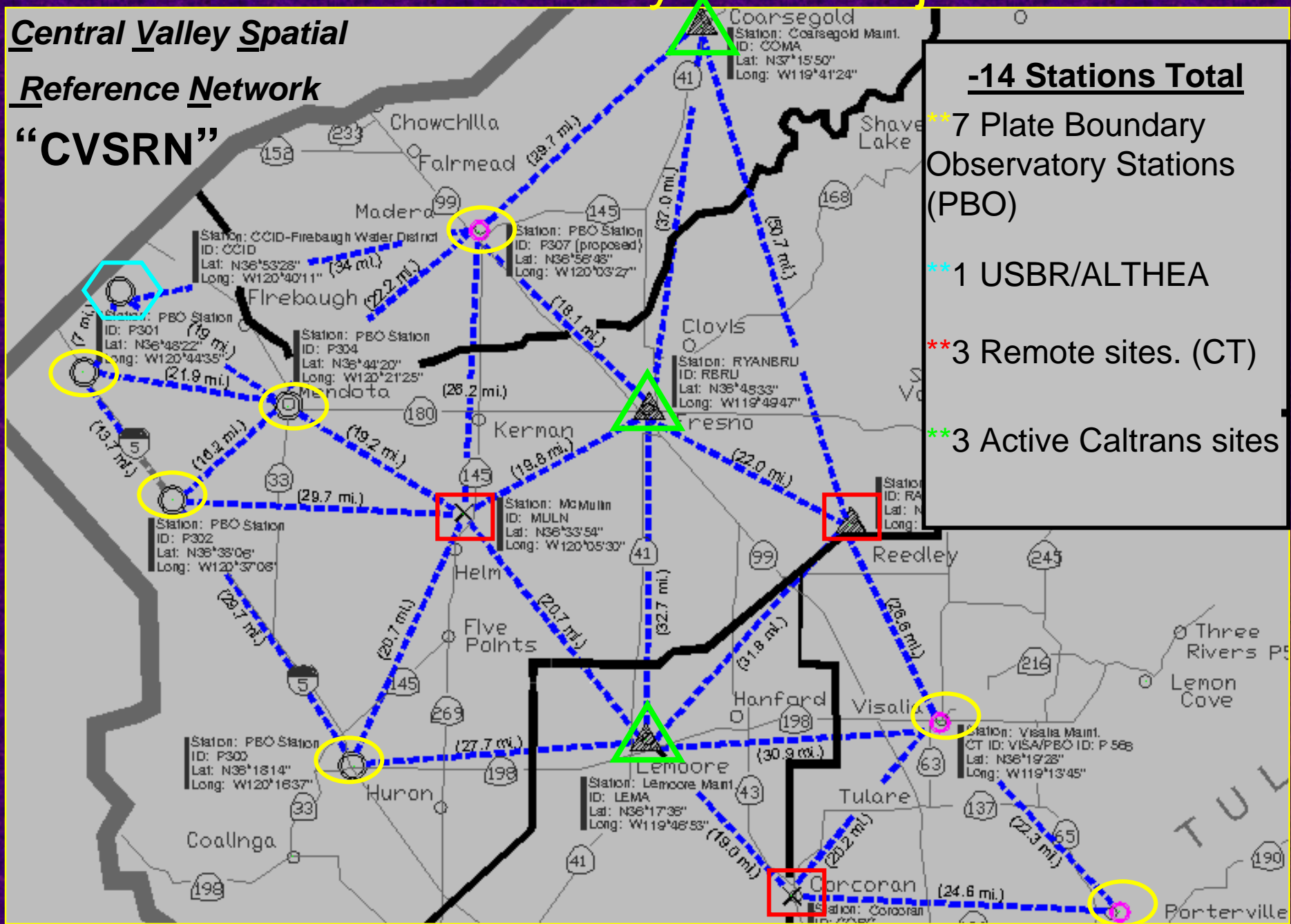


# Central Valley Pilot Project

## Central Valley Spatial

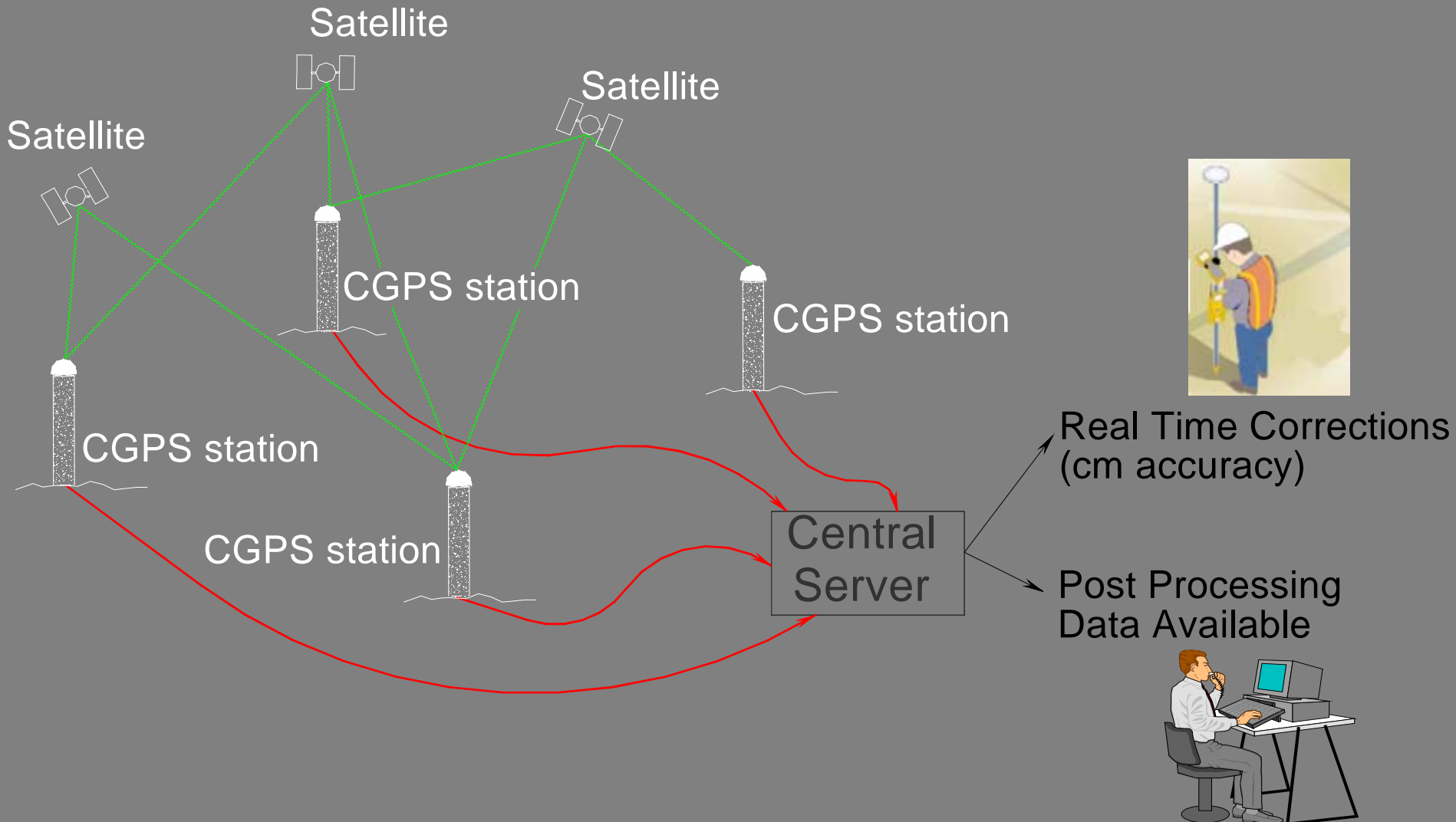
## Reference Network

“CVSRN”



# CVSRN

Strategically plan Network to encompass Highway Corridors  
Build and install Permanent CGPS Stations.





# What does this really mean?

This system will serve as infrastructure that can be used by a variety of disciplines. Here is one example of how this system will effect Caltrans Surveys on a day to day basis.

# A Typical Day of Surveying



- Construction Staking
- Right of Way monumentation/Recovery
- Control Work
- Design Surveys – Topographical Mapping
- Land Net Recovery and coordination
- Flight panel layout and coordination.



Crew Sets up Radio base  
Communications



Crew Sets up Base  
Station GPS unit





## Crew Sets up RTK Rover unit and communication



Leave Crew Member for  
Security of equipment





.....and the crew goes to work.....



-once the crew reaches a distance of 3 to 5 km from the base (depending on line of site for radio communications and degradation of the distance dependent solution) the process has to be repeated.

The base station has to be moved up to a location closer to the actual work site.



With the implementation of the CVSRN





# Which means we can.....



- Improve our production.
- Reduce set-up time
- Minimize distance related communication constraints and distance related solution degradation





# Why Network RTK? Why Now?

- The accuracy of our traditional databases have been surpassed by our current surveying technology.
- The effects of plate tectonics and subsidence are real and measurable. With the implementation of Real Time Network, the modeling of these movements gives us an “up to date” method of coordinating our project control that fits real world conditions.
- Partnering opportunities between the public sector, private sector and academia provide unique opportunities to bring a Real Time Network to the Central Valley.
- Network RTK will allow us to become more efficient and provide better Service quality to our Customers.

# Site Design

## Primary Considerations

Site Location:

Geometric Strength of figure (Network configuration)

Power and Communication Links

Security

Clear Sky view (obstructions)

Site Testing Using TEQC

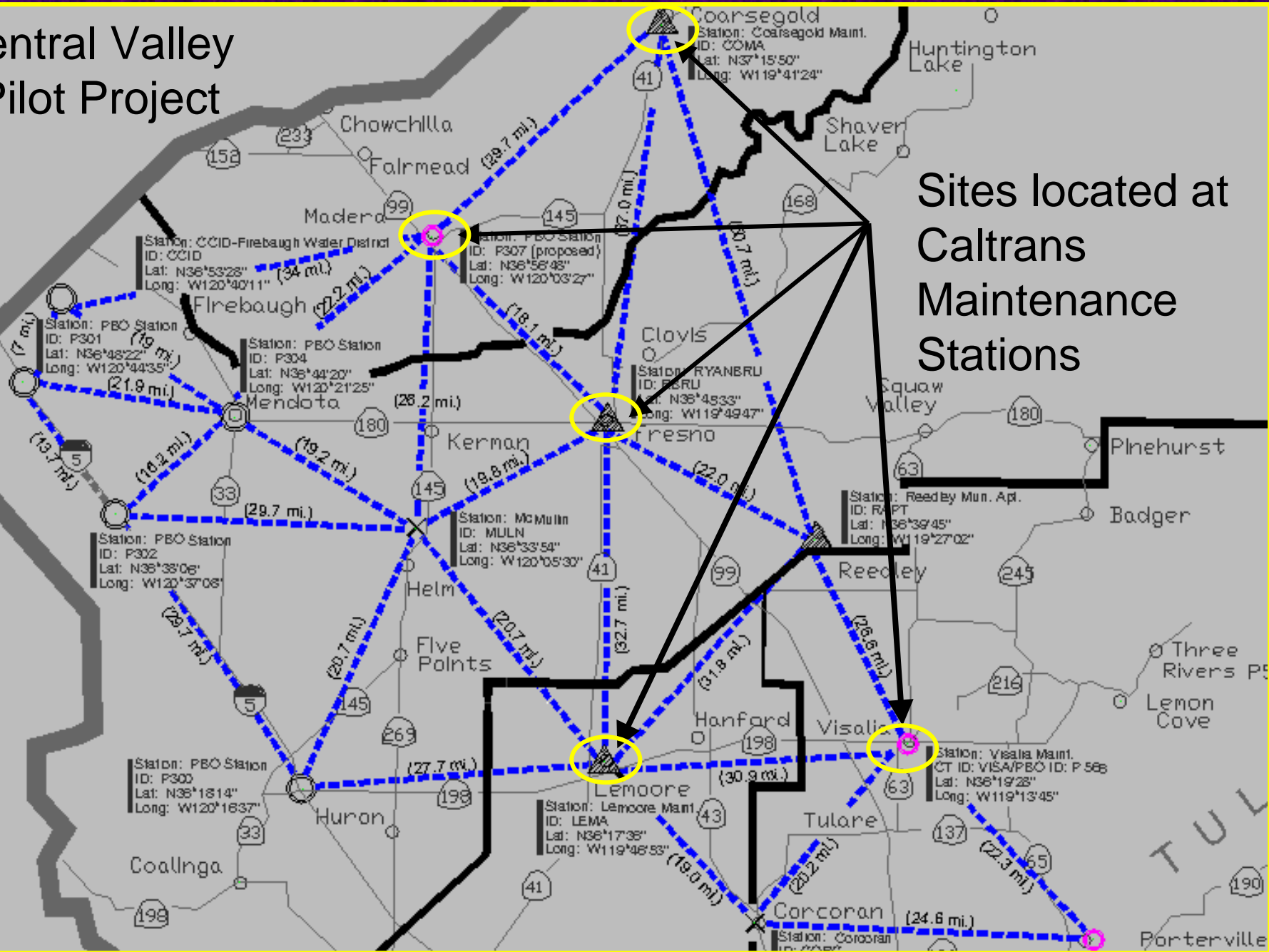
Prefer Caltrans Maintenance Stations

```
graph TD; A[Geometric Strength of figure (Network configuration)] --> E[Prefer Caltrans Maintenance Stations]; B[Power and Communication Links] --> E; C[Security] --> E; D[Clear Sky view (obstructions)] --> E; F[Site Testing Using TEQC] --> E;
```



# Central Valley Pilot Project

# Sites located at Caltrans Maintenance Stations



# Site Analysis

- TEQC evaluation

- Software used and provided by UNAVCO to evaluate strengths and weaknesses with respect to site evaluations and GPS data collected at the site.
- Suggest 48 hrs of data collection.
- Reports on Multi-path; reports and detects observation data gaps; Provides Counts of ionospheric delay slips and “observations per slip”; report of elevation mask at loss of satellite .....among other things....



# Site Monuments & Installation

Site Installation:

Monument Type → Braced Height (PBO)  
→ Modified NGS Pillar





# PBO Braced Height Mon. Installation





# PBO Braced Height Mon. Installation





# PBO Braced Height Mon. Installation



# PBO Braced Height Mon. Installation





# PBO Braced Height Mon. Installation





# PBO Braced Height Mon. Installation

P307-Madera Maintenance Station





## Attaching to PBO



# Attaching to PBO





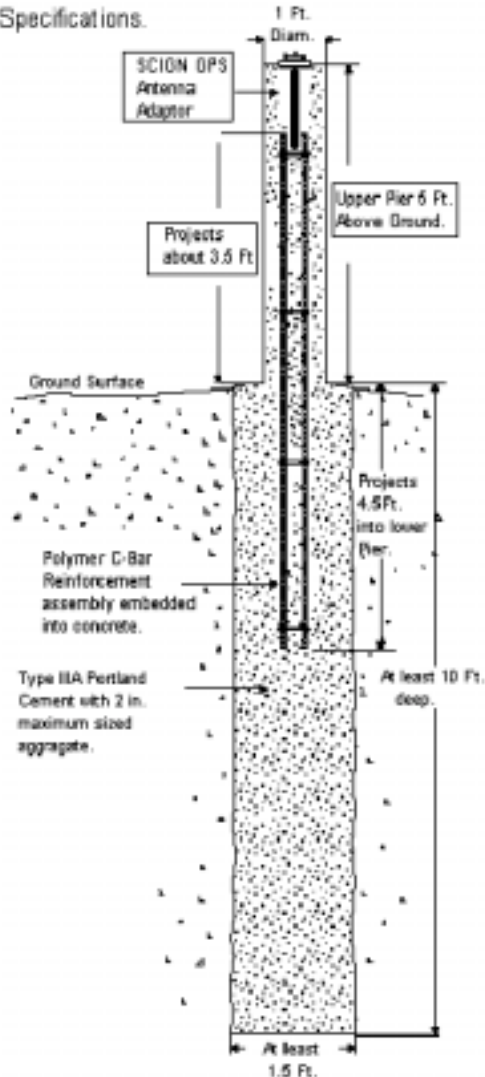
# Attaching to PBO





# Caltrans Pillar type Mon. Installation

Modified NGS  
Specifications.



Caltrans Monument design is a “modified” NGS Specification.

Extended the pillar 10 feet above ground to minimize multi-path and open up sky view.

20 foot fiberglass “rebar” rather than 8 feet.

The height gave us added security!



# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation



# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation



10' X 1.5' hole.



# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation



# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation



# Caltrans Pillar type Mon. Installation





# Caltrans Pillar type Mon. Installation



# Equipment Installation





# Equipment Installation

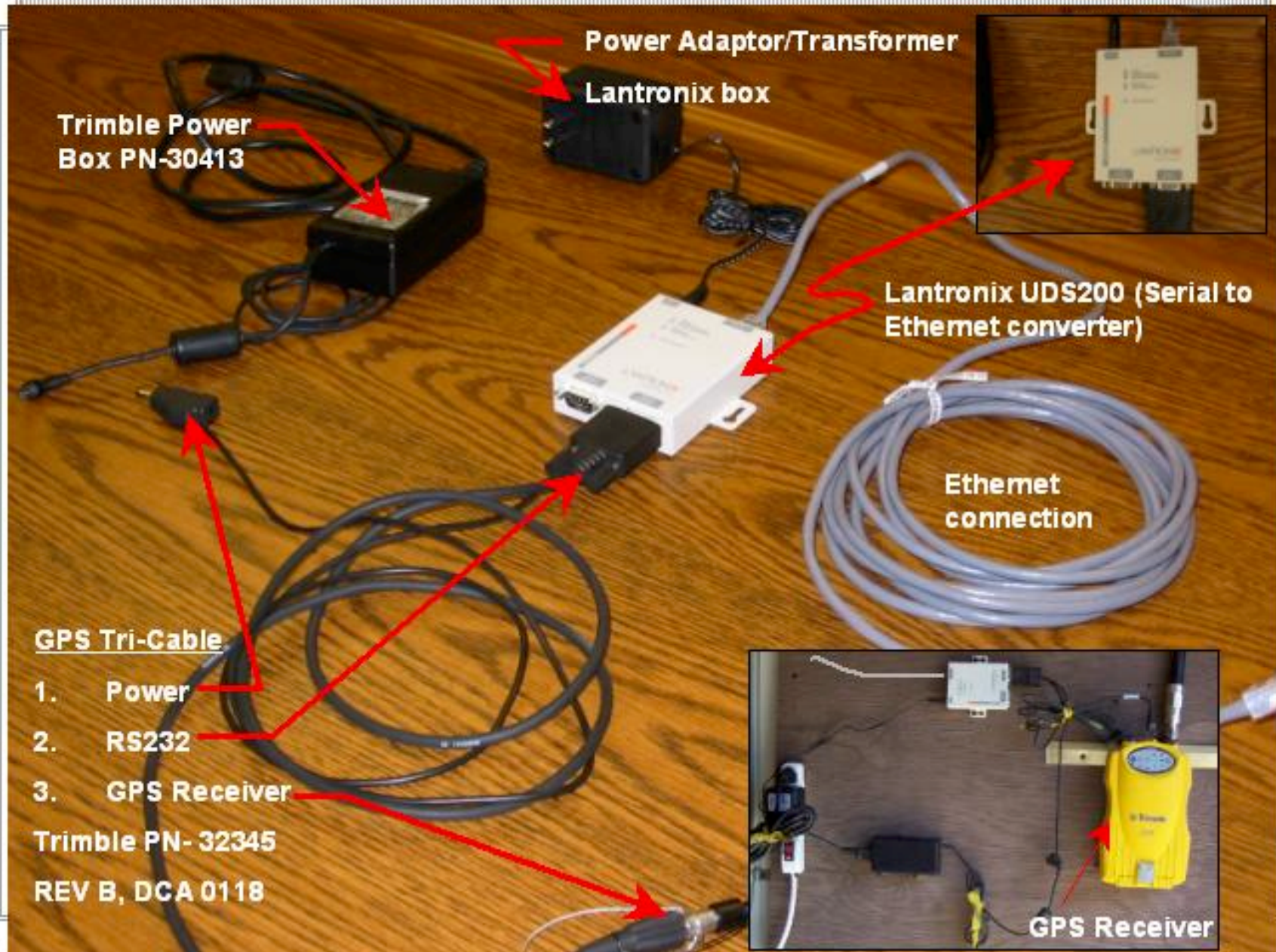


# Equipment Installation



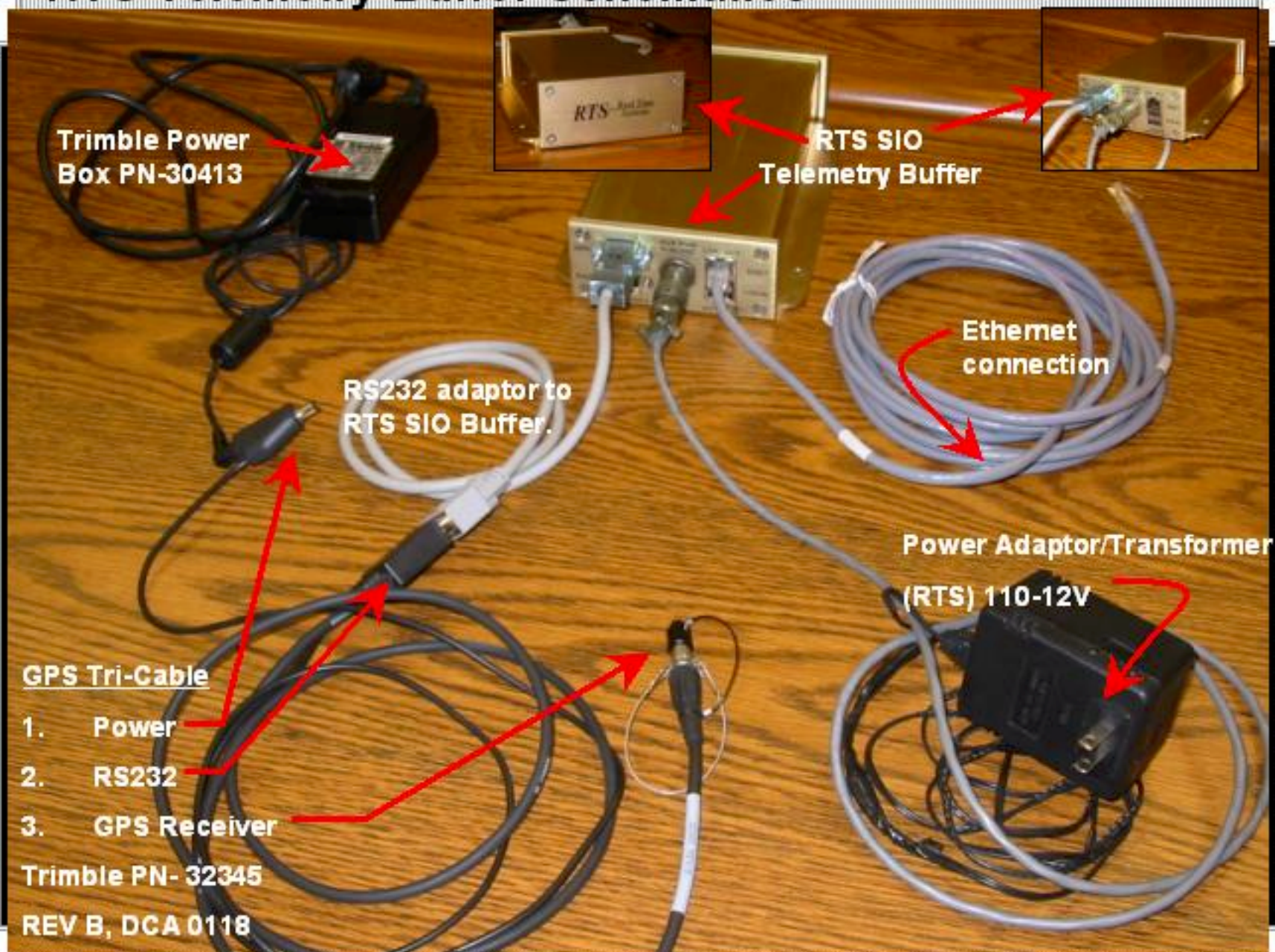


# Lantronix Serial to Ethernet Schematics





# RTS Telemetry Buffer Schematics





# Equipment Installation





## Ideal Site configuration.

RBRU-Fresno D.O.

- Piped Power Supply
- Direct data drop into CT intranet
- Secure site



# Communications & Telemetry

3 current types of Solutions:

- Direct Connect by Ethernet into Caltrans Intranet network

- Point to Point radio solution

  - \*Short Distance transmissions. (i.e. Across a maintenance yard.)

- 2.4ghz / 900mhz (WiLan) radio solution

  - \*Distances greater than 1 mile or less 60 miles.

Both Radio solutions include direct data drops into the Caltrans intranet.

# Point to Point Radio Solution





# Point to Point Radio Solution





## 2.4Ghz / 900Mhz Radio Solution














## 2.4Ghz / 900Mhz Radio Solution



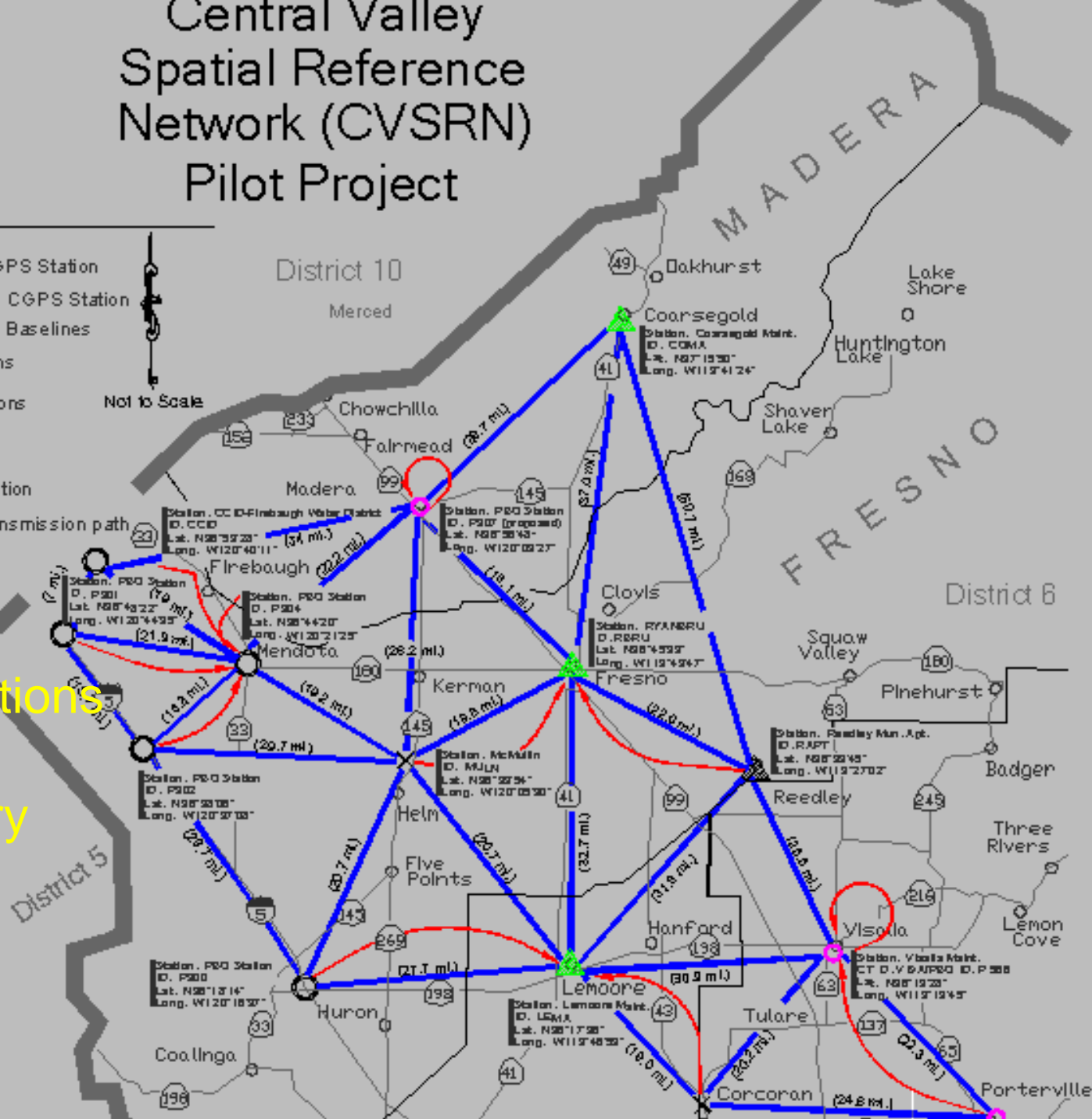
# Central Valley Spatial Reference Network (CVSRN) Pilot Project

## Legend

-  County Lines
-  Active Caltrans CGPS Station
-  Proposed Caltrans CGPS Station
-  Proposed Network Baselines
-  Active PBO Stations
-  Maintenance Stations
-  CT Remote Site
-  Proposed PBO station
-  Proposed Data transmission path

Not to Scale

Communications  
and  
Telemetry





# Strength of Signal Testing





# CVSRN

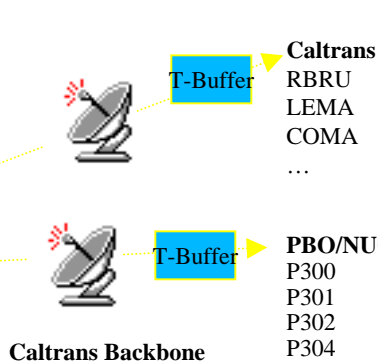
## Fresno



IP: 10.48.  
Xx.xx(multiple  
ports)

**CLP/Fresno**

RBRU	IP#1/Port #1
LEMA	IP#2/Port #2
COMA	IP#3/Port #3
P300	IP#4/Port #4
P301	IP#5/Port #5
P302	IP#6/Port #6
P304	IP#7/Port #7
...	...



- PBO/NUCLEUS**
- P300
  - P301
  - P302
  - P304
  - BEPK
  - ISLK
  - CCCC
  - RAMT
  - PHLB
  - RSTP
  - THCP
  - EDPP
  - WGPP
  - BVPP
  - ARM1
  - ...



## DMZ



IP: 64.174.  
(multiple ports)

Internet

Internet

General Users



## CSRC

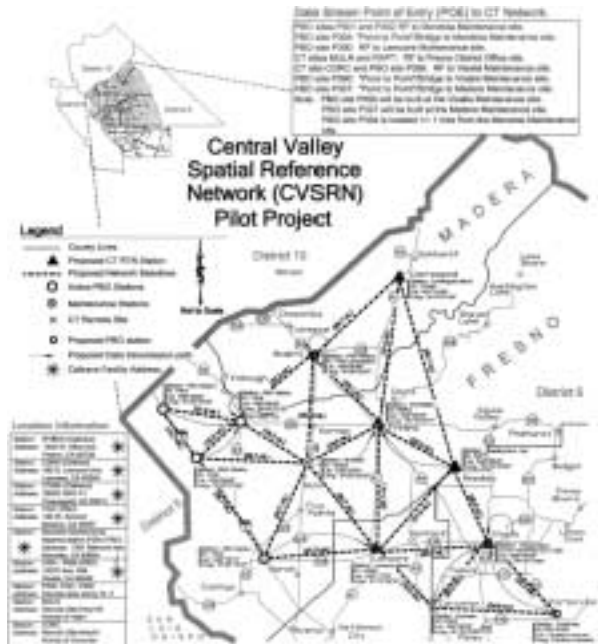


IP: 132.239.152.74  
(multiple ports)

Science Users

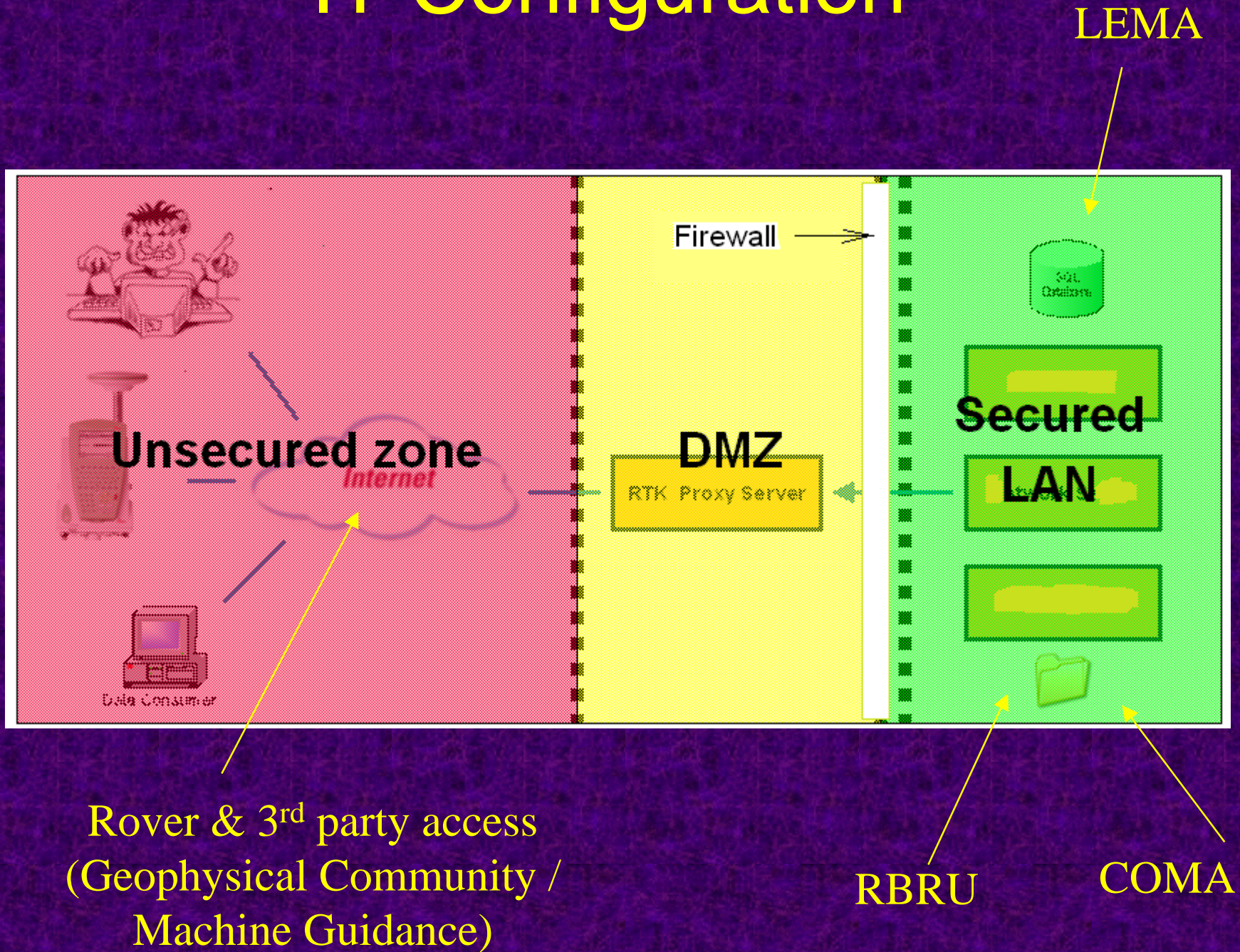


SOPAC Archive





# IT Configuration







Rover End







# Software / Evaluation

## Software.

- *Trimble RTKnet.*
- *Geodetics Inc.- RTD / Smartclient*
- *Leica - Spider 2*

## Evaluation

- *Network Solution*
- *Cost*
- *Tech Support*
- *Support Various Vendor Equipment*
- *Scalability*
- *Support Multi Vendor data streams*



# Users-Who will Benefit?

Cities and Counties. (Surveyors, Public Works, GIS Users, Safety Services, Engineering)

Scientific Community -- Geophysical

Local Surveyors. — Boundary, Construction, Mapping, Control

GIS Community — Precise GIS Mapping (from 1meter to 30cm)

Public Utilities. — Precision As-builts

Airports-Navigation (LAAS), Precise Weather

Agriculture Community- Precise Farming.

Construction Industry - Machine Guidance.

Education Community.— Research & Training


Transportation-Smart Vehicles.

# Current Partnering

- **CSRC-California Spatial Reference Center**
  - *in kind services (Ht. Mod. Leveling/Technical Assistance)*
- **PBO-Plate Boundary Observatory**
  - *in kind services (Permitting/Access to data streams)*
- **City of Reedley / Reedley Airport Comm.**
  - Site location assistance*



# Current Support /Targeted Support & Users

- *Office of Land Surveys*
  - *District 6 IT / Headquarters IT*
  - *District 6 TMC*
  - *District 6 Maintenance*
  - *District 6 Telecommunications*
- 
- ```
graph LR; FSR[FSR Funding] --> OLS[Office of Land Surveys]; FSR --> D6IT[District 6 IT / Headquarters IT];
```
- 

## *-- In-House Departments*

*– Airports-LAAS*

*– Cities-GIS, Surveys, Emergency*

*– Counties-GIS, Surveys, Emergency*

*→ Maintenance*

*→ Traffic Management Center*

*→ Environmental*

*→ GIS*

*→ Construction / Design*

# Cost Recovery / Maintenance

## Recovery Analysis

(Our Crews utilize RTK tools +/-80% of the time.) / (Pilot Project will effect 3 to 4 crews.)

### **-Initially Identified Areas where recovery of costs could be realized.**

**Recovery #1:** Reduce or eliminate crew time setting up base station and radio at the beginning of the day and the end of the day.

**Recovery #2:** Eliminate the need for a crewmember to protect the base station / increase production.

**Recovery #3:** Reduction in the amount of Project Control.

**Maintenance:** Negligible annual and occasional maintenance.

**- Pilot Project - Recoup costs within 8 months of fully operational system.**

(Upon Completion of the Long Term Plan, it will effect 8 crews)

**- Long Term Project - Recoup costs within 10 months of fully operational system.**

\$\$\$ - Project will serve as a Sustained Economic Benefit for the Department.



# Pilot Project Goals

- Develop Statewide Specifications and Standards.
- Develop a Scalable Infrastructure - Orange County-San Diego County-Metropolitan Water District-Las Vegas Valley Water District, Ohio DOT, Michigan DOT
- Develop a “Better Cheaper Faster Safer” (BCFS) way of doing business as well as improve efficiencies.
- Show that the Project will serve as a sustained economic benefit for the Department.
- Assist Local Communities in Technological Growth through partnering efforts.

# Pilot Project Implementation / Timeline

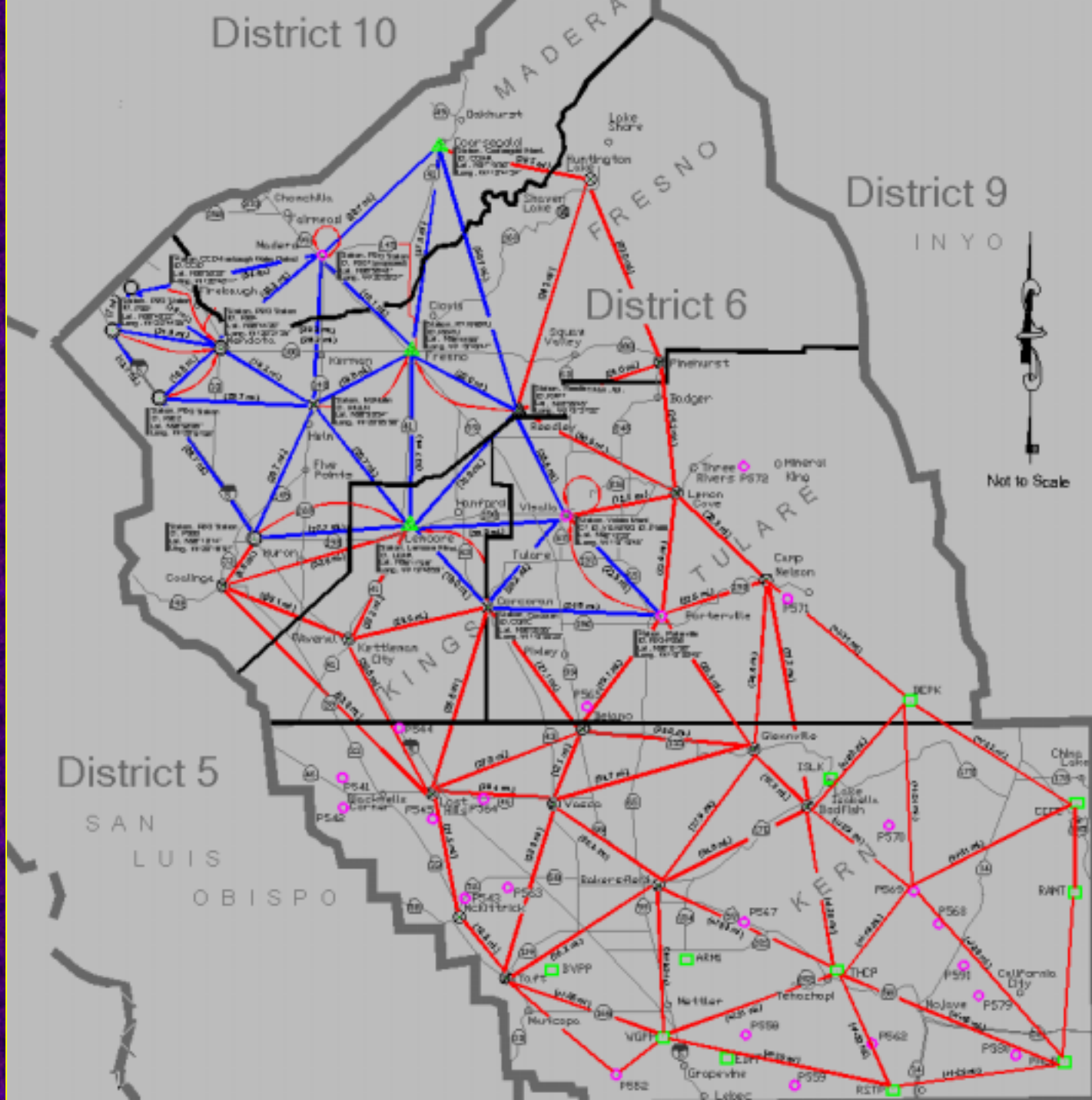
|                       |                                               |
|-----------------------|-----------------------------------------------|
| Currently             | IT / Telemetry / Rover Communications Testing |
| February-April - 2006 | Complete GPS / Telemetry Installations        |
| May - 2006            | Begin Software Evaluation.                    |
| Winter - 2006         | Pilot Project Implementation                  |

Schedule Subject to Funding timelines.



The Big  
Picture...

CVSRN build-  
out plan







Frank Quevedo



Pavel Popov



Eric Adney



Bud Klassen



Pete Reyes



